

HOMING IN EASTERN FENCE LIZARDS (*SCELOPORUS UNDULATUS*) FOLLOWING SHORT-DISTANCE TRANSLOCATION

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ABSTRACT.—We conducted an experiment on eastern fence lizards (*Sceloporus undulatus*) during August–September 1995 near Los Alamos, New Mexico, (1) to ascertain if lizards that were relocated short distances exhibited homing, (2) to investigate a possible barrier to movement, and (3) to determine the effect of translocating individuals from a transplant area on lizards in a recipient area. We relocated 15 of an estimated population of 39 (95% CI 36–45) lizards an average distance of 46 m. Fourteen of 15 translocated lizards returned to within 6.81 ($s_{\bar{x}} = 1.43$) m of the original capture location. Movement distances did not vary ($F = 0.76$; 1,53 df; $P = 0.381$) between resident and translocated lizards during the pretreatment period and did not vary for resident ($F = 2.86$; 1,12 df; $P = 0.1166$), but varied between pretreatment and posttreatment periods for translocated ($F = 14.65$, 1,7 df, $P = 0.0065$) lizards. Translocated lizards did not affect the resighting probability of resident lizards ($F = 0.96$; 1,14 df; $P = 0.34$), but this may be related to low power ($1 - \beta = 0.15$) and translocated lizards moving out of the area quickly.

Key words: barrier, disturbance, eastern fence lizard, *Sceloporus undulatus*, homing, New Mexico, translocation.

Some reptile species may be relocated to mitigate habitat-related conflicts or for humane reasons (Dodd and Seigel 1991); nevertheless, *Sceloporus* spp. may exhibit homing (Noble 1934, Mayhew 1963, Weintraub 1970, Guyer 1978, Ellis-Quinn and Simon 1989), thus reducing the effectiveness of translocations. If eastern fence lizards (*Sceloporus undulatus*) are translocated, it is unknown whether a subsequent increase in density in surrounding areas may cause some individuals in the resident population to be adversely affected (e.g., see Noble 1934, Tubbs 1975, Reinert 1991, Gordon 1994).

Thick vegetation or open habitat may form barriers to dispersal and movements for eastern fence lizards (Noble 1934, Jones and Droge 1980, Tinkle 1982). The ability of animals to traverse the surrounding habitat matrix may determine the number of animals reaching a given distance from or returning to a source population; however, corridors may provide important landscape components for dispersing animals (Noss 1983, Inglis and Underwood 1992).

This study was designed to determine if lizards translocated <70 m across a 55 × 17-m-wide patch of vegetation would return to the site of capture or remain in a different locale. Additionally, we simulated an immigration event

and investigated the effect of transplants on resident lizards in a different area.

The study was conducted on a 4355-m² area located in Los Alamos, New Mexico (35°53' N, 106°20' W), at an elevation of 2165 m. The study site is divided into a south (1520 m²) and north (1900 m²) area by a 55 × 17-m patch of dense vegetation, which is bordered on the southern portion of the north side by a 3-m-wide arroyo. Each area is composed of moderate to steep talus slopes with a wide range of boulder sizes; a nearly vertical canyon wall creates a boundary for approximately one-half of these areas. The site also contains a 0.5-m-wide trail, running approximately south–north, which connects the 2 areas and may provide a corridor for movements. Predominant vegetation in the 55 × 17-m-wide interstitial area consists of bromes (*Bromus* spp.), yarrow (*Achillea lanulosa*), apache plume (*Fallugia paradoxa*), and ponderosa pine (*Pinus ponderosa*).

We captured, marked, and/or resighted eastern fence lizards during daily surveys that lasted approximately 1.5 h during the mornings of 14–17, 20–25, and 28 August 1995. Lizards were sexed, measured from snout to vent (SVL), and individually marked using canary yellow Liquid Paper[®] (The Gillette Co., Boston, MA) with a 1 × 1.5-cm number on their dorsal

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surface. We assumed marking did not affect lizards (Noble 1934, Jones and Ferguson 1980).

Prior to initiating the experiment, we conducted mark-resight surveys and estimated a daily population size of 39 (95% CI = 36–45; Hein and Myers 1995). Minimum daily movement distances were determined during mark-resight surveys conducted in the pretreatment period (i.e., 14–28 August) by measuring the distance from the first sighting of an individual to the next sighting on subsequent days. Resighting probabilities (c) were calculated by summing the number of times each resident lizard was observed, divided by the number of surveys past the initial capture and marking, during pretreatment (c_{pre}) and posttreatment (c_{post}) periods. We translocated lizards during 29–31 August 1995 and continued resighting lizards through 3 September 1995. We also surveyed the study area on 19 September 1995 for 1 h.

We randomly selected the south area as the transplant population, meaning recaptured individuals were relocated to the north area. We attempted to recapture all lizards (transplants and residents) and remark with Liquid Paper[®]. Resident lizards were released at the site of recapture. The north area was subdivided into a grid of 4 equal-area cells, with each cell approximately 475 m². We randomly selected 1 of the 4 cells to receive the first translocated lizard; subsequent lizards were systematically placed in the next higher numbered cell. Translocated lizards were placed in the center of each cell. The shortest distance that lizards were relocated was greater than the largest radii calculated from reported home range estimates (13.0 m, Turner et al. 1969; 15.0 m, Martins 1994); therefore, translocated lizards were believed to have been displaced outside the normal range of their movements. Unmarked lizards captured on the south side were also marked and translocated. We measured the straight-line distance from each capture location (south) to each release site (north) and the distance from each subsequent resighting to the original point of capture until the lizard was within 10 m of the capture location or the study ended. Straight-line distances were used to calculate Griffin's index (Griffin 1952, Weintraub 1970), which measures the directness of a translocated animal's return (i.e., homing) path. Successful homing, following translocation, was defined as moving from the north to the south

side of the canyon to within the area where we had repeatedly observed each individual, or within 10 m of the original point of capture for individuals that were not observed prior to translocating. We also measured long-distance movements for 2 lizards (ID nos. 2 and 18) that were observed twice during 1 survey.

All distances were normalized by log transformation prior to analyses. We compared mean distances moved and SVL between transplant and resident lizards during the pretreatment period using analysis of variance, whereas SVL in relation to distances moved was compared using regression (PROC GLM, SAS Institute Inc. 1988). All other comparisons of distances that individual lizards moved were tested using a repeated measure analysis of variance (PROC GLM, SAS Institute Inc. 1988). We also tested whether transplants adversely affected residents by comparing resighting probabilities among resident lizards between pretreatment and posttreatment periods using a repeated measure analysis of variance (PROC GLM, SAS Institute Inc. 1988). Because we used a repeated measures analysis of variance, each lizard acted as its own control, and the normal between experimental unit (i.e., lizard-to-lizard) variation from the error sum of squares was thus removed. Power ($1 - \beta$) of tests was also calculated for each comparison (SAS Institute Inc. 1988).

RESULTS

Movement distances did not vary ($F = 0.76$; 1,53 df; $P = 0.381$; $1 - \beta = 0.83$) between the resident and transplanted lizards during the pretreatment period and did not vary between periods for resident ($F = 2.86$; 1,12 df; $P = 0.1166$; $1 - \beta = 0.34$) lizards, but they varied between periods for translocated ($F = 14.65$; 1,7 df; $P = 0.0065$; $1 - \beta = 0.91$) lizards. Additionally, distances moved by lizards between north and south areas differed between pretreatment and posttreatment periods ($F = 15.80$; 1,19 df; $P = 0.0008$; $1 - \beta = 1.00$). SVL did not differ ($F = 1.89$; 1,115 df; $P = 0.171$; $1 - \beta = 0.28$) between transplant and resident lizards. There was no relationship between SVL and distance moved ($F = 1.65$; 16,34 df; $P = 0.107$; $1 - \beta = 0.79$) between lizards during the pretreatment period.

Thirteen of 15 (7 female, 8 male) translocated lizards exhibited homing by moving to the

TABLE 1. Summary of eastern fence lizards translocated <75 m in Los Alamos, New Mexico, during August–September 1995.

| ID | Sex | SVL (mm) | Translocated distance (m) | Homed distance ^a (m) | No. days to home | Griffin's index |
|----|-----|----------|---------------------------|---------------------------------|------------------|-----------------|
| 1 | F | 77 | 41.20 | 4.02 | 3 | 1.05 |
| 2 | M | 60 | 65.80 | 15.40 | 1 | 1.40 |
| 4 | F | 56 | 23.80 | 16.29 | 2 | 1.04 |
| 7 | F | 67 | 38.80 | 9.40 | 1 | 1.04 |
| 10 | F | 66 | 51.05 | 2.89 | 3 | 1.07 |
| 11 | M | 46 | 59.70 | 5.00 | ≤21 | 1.02 |
| 15 | M | 56 | 57.50 | 3.20 | 1 | 1.12 |
| 18 | M | 60 | 63.40 | 1.85 | 1 | 1.39 |
| 42 | F | 66 | 40.40 | — ^b | — | — |
| 43 | M | 57 | 49.35 | 8.80 | 2 | 1.17 |
| 44 | F | 62 | 40.70 | 7.26 | 2 | 1.20 |
| 45 | M | 48 | 39.05 | 11.65 | 3 | 1.95 |
| 46 | M | 66 | 37.50 | 1.69 | 3 | 1.09 |
| 47 | M | 52 | 59.03 | 1.10 | 3 | 1.02 |
| 48 | F | 57 | 31.20 | 5.09 | 1 | 1.64 |

^aDistance from the original point of capture prior to translocating.

^bDid not demonstrate homing, but was resighted 1 time in the northern area.

south side of the canyon, within an average of 6.81 ($s_{\bar{x}} = 1.43$) m of the original capture point in 2 d ($s_{\bar{x}} = 0.25$; Table 1). Translocated lizards moved an average of 7.68 ($s_{\bar{x}} = 1.47$) and 22.17 m ($s_{\bar{x}} = 4.42$), whereas resident lizards moved an average of 6.37 ($s_{\bar{x}} = 1.0$) and 10.0 m ($s_{\bar{x}} = 1.68$) during pretreatment and post-treatment periods, respectively. One additional translocated lizard was observed within 5 m of the original point of capture on 19 September 1995. Griffin's index averaged 1.20 ($s_{\bar{x}} = 0.07$), indicating that, on average, translocated lizards moved 1.2 times the relocated distance as they were returning to the capture location. Lizards 2 and 18 moved 43.1 and 16.4 m in 71 and 80 min, respectively.

Eight (4 female, 4 male) of 14 lizards were recaptured and translocated, whereas 7 (3 female, 4 male) unmarked lizards were captured and relocated. We recaptured and remarked 10 (2 female, 8 male) of 18 resident lizards and did not capture or sight any unmarked lizards in the resident area. Fifteen of 18 resident lizards were resighted an average of 2.17 ($s_{\bar{x}} = 0.29$) times during the experiment. During the study, lizards were captured and/or resighted on the canyon floor, talus slopes, and corridors (i.e., trail and stream), whereas no marked lizards were captured or resighted and no unmarked lizards were observed in the patch of vegetation.

Resighting probabilities did not differ ($F = 0.96$; 1,14 df; $P = 0.34$) between pretreatment

($c_{\text{pre}} = 0.58$, $s_{\bar{x}} = 0.06$) and posttreatment ($c_{\text{post}} = 0.49$, $s_{\bar{x}} = 0.05$) periods for individual resident lizards, but this may be related to low statistical power ($1 - \beta = 0.15$) because of a small effect size (0.09) and/or sample size ($n = 15$).

DISCUSSION

In our study the majority (14 of 15) of eastern fence lizards exhibited homing by returning to the south side of the canyon, with most (11 of 14) lizards returning to <10 m from the original capture location. This finding agrees with other studies that demonstrated homing in lizards (*Sceloporus* spp.) that were translocated ≤ 240 m (Noble 1934), ≤ 150 m (Mayhew 1963), ≤ 215 m (Weintraub 1970), ≤ 280 m (Guyer 1978), and ≤ 200 m (Ellis-Quinn and Simon 1989). Male and female eastern fence lizards homed equally well (Table 1). Although we did not estimate home ranges, the minimum daily movement distances during the pretreatment period indicate that all lizards were relatively sedentary; however, we cannot rule out that some translocated individuals may have been familiar with the northern area, and we suspect that lizards successfully homed because translocated distances were relatively short (i.e., ≤ 65.8 m). No lizards were observed in the patch of dense vegetation; it may have inhibited movements. Alternatively, lizards were observed on or near the small trail and streambed, which suggests these features may

have been used as corridors between the 2 areas; corridors may provide important landscape components for dispersing animals (Noss 1983, Inglis and Underwood 1992).

We did not detect an effect on the resighting probabilities of resident lizards by translocated lizards, but our test had poor power ($1 - \beta = 0.15$) because of a low effect size (0.09) and small sample size ($n = 15$). If the effect size had been large (e.g., >0.45), which might imply the biological significance of an immigration event was high, then the power of this test would have been strong (i.e., >0.80). We resighted 15 of 18 residents ≥ 1 time during the experiment, suggesting translocated lizards did not cause resident lizards to emigrate; however, lizards were capable of moving large distances in a short amount of time, and the translocated lizards spent relatively little time (2 d) among the residents. The amount of time for translocated lizards to home was shorter than studies that displaced *Sceloporus* spp. greater distances than our study (Noble 1934, Ellis-Quinn and Simon 1989), but similar to a study with shorter (<125 m) displacement distances (Weintraub 1970).

We did not detect any deleterious effects of translocating lizards on the resident lizards; however, if small-scale habitat disturbance causes fence lizards to emigrate into neighboring areas, resident lizards in these areas may be affected. Translocating eastern fence lizards may cause residents to display aggressively or attack (Noble 1934), which may affect survival and reproduction (Vinegar 1975). Similarly, artificial crowding may affect *Sceloporus* spp. by reducing growth and/or survival rates (Tubbs 1975). Consequently, future studies should investigate whether translocated or resident lizards are affected (e.g., increased aggression or lower survival) by immigration events.

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